

WE CLAIM:

1. A system for manufacturing a product, said system comprising:

5           a first workstation operable to perform a first manufacturing action on parts of said product, said first station having a first entrance and a first exit;

10          a second workstation operable to perform a second manufacturing action on said product parts, said second station having a second entrance and a second exit;

15          a product transport line between said first exit and said second entrance, said line operable to move said product parts under computer control; and

20          a chamber enclosing a portion of said transport line, including means for providing a balanced, coordinated throughput from said first station to said second station, and means for exposing said product parts to computer controlled environmental conditions while being transported through said chamber.

2. The system according to Claim 1 wherein said transport line comprises a mechanical system including movable platforms suitable for holding said product parts.
- 25         3. The system according to Claim 2 wherein said product parts comprises semiconductor devices.
- 30         4. The system according to Claim 1 wherein said balanced throughput comprises waiting lines for said product parts and computer-controlled monitors for product position and time in said chamber.

5. An apparatus for receiving, storing, transmitting, and releasing manufactured products, said apparatus suitable for insertion into the manufacturing flow at various stages of product fabrication, comprising:
  - 5 a chamber for maintaining specified environments; said chamber having a computer-controlled entry and exit;
  - a transport system connecting said entry and exit, said system including movable platforms suitable for transporting said product, said system designed to create waiting lines for said product loaded on said platforms; and
  - 10 computer-controlled monitors for position and time of said platforms, said monitors operable to achieve a balanced product throughput through said chamber.
6. The apparatus according to Claim 5 wherein said chamber environments include computer-controlled gaseous ambient, humidity, and temperature.
- 20 7. The apparatus according to Claim 5 wherein said product comprises semiconductor devices.
8. The apparatus according to Claim 5 wherein said waiting lines are structured as horizontally rotatable carousels.
- 25 9. The apparatus according to Claim 5 wherein said waiting lines are structured as vertically rotatable wheels.
10. The apparatus according to Claim 5 wherein said waiting lines are structured as elongated conveyor systems.
11. The apparatus according to Claim 5 wherein said inlets and outlets are supported by sensors feeding their observations back to said computer control.
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12. A method for stress-reduced assembly of a semiconductor device, including a chip having at least one contact pad and a substrate having at least one terminal pad, comprising the steps of:

- 5        positioning said substrate on a pallet;
- attaching a reflow element to said chip contact pad;
- flipping said chip onto said substrate so that  
              said reflow element is placed in contact with  
              said substrate terminal pad;
- 10      moving said pallet into a first workstation,  
              including means for performing reflow operations;
- supplying thermal energy to said chip and said  
              substrate sufficient to reflow said element,  
              thereby creating an assembly of chip and
- 15      substrate spaced apart by a gap;
- transferring said pallet including said assembly  
              from said first workstation into a first chamber  
              maintained at a constant first temperature, and  
              positioning said pallet in a waiting line for a  
              first period of time;
- 20      withdrawing said pallet from said waiting line and  
              moving said pallet into a second workstation  
              including means for performing underfill  
              operations;
- 25      filling said gap with a polymer precursor;
- transferring said pallet including said filled  
              assembly from said second workstation into a  
              second chamber maintained at a constant second  
              temperature sufficient to polymerize said  
              precursor, and positioning said pallet in waiting  
              line for a second period of time;
- 30      completely polymerizing said precursor; and

withdrawing said pallet from said waiting line and  
cooling the completed assembly to ambient  
temperature.

13. The method according to Claim 12 wherein said heating  
5 and cooling steps are performed at computer-controlled  
ramp rates to relieve thermo-mechanical stress.
14. The method according to Claim 13 wherein said  
temperature ramps, together with said waiting times at  
constant temperature relieve thermomechanical stress.
- 10 15. The method according to Claim 12 wherein said step of  
polymerizing the precursor is executed in two phases, a  
partial polymerization performed in said second  
workstation followed by a complete polymerization in a  
third workstation.

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